Geophysical Research Abstracts
Vol. 12, EGU2010-9827, 2010
EGU General Assembly 2010

Homogenization of monthly rainfall series in the Grand-Duchy of Luxembourg

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Long-term climatological series are subject to many temporal fluctuations, which are either climatic variations or artificial shifts (changes of location, equipment, observer...). The statistical homogeneity of time series is defined by the intrinsic variability of variables in time (natural variations). This property can be affected by different kinds of errors (individual or systematic errors), which have an artificial origin. Data homogenization is a preliminary necessary step for assessing temporal climate variations and trends. The classical homogenization approach would consist in making inter-comparisons between the staffgauge stations and compare them to a reference time series (homogeneous series representative of the study area), through several statistical tests (double-mass curves, linear regressions...). Indeed most homogenization techniques require the use of a reference data series, which are in turn very difficult to determine given the fact that, each time series is likely to contain data errors. Therefore, a homogenization method avoiding the use of reference data series, the Regional Vector Method, has been preferred for setting-up a long-term monthly rainfall database for the Grand-Duchy of Luxembourg since 1949. This method is based on a fictive representative series (Regional Vector) that summarizes all information of the study area. The Regional Vector allows detecting individual errors in time series according to confidence intervals and proposes corrections and estimations of missing data. A statistical time series segmentation method has also been applied for detecting homogeneity breakpoints in rainfalls series. This method allowed detecting average changes using cumulative sums of data according to confidence intervals, which are commonly used by climatologists and hydrologists. In our case, this method has been applied for validating rainfall homogenization as well as for attesting that only climatic shifts have been conserved. Detected homogeneity breakpoints have been identified according to the metadata available and through inter-comparison of staffgauge stations and the knowledge of past climate conditions. Finally, 24 monthly homogenous and continuous rainfall series are available throughout the country since 1949. Rainfall homogenization will allow assessing temporal rainfall variability and trends for the past sixty years. Annual and seasonal rainfall analyses will allow determining also the spatial variation of their distributions, which is linked both to topographic effects and atmospheric circulation patterns. Indeed rainfall distributions in the Grand-Duchy of Luxembourg are characterized by a strong negative West-East gradient due to an orographic effect, which is accentuated under westerly atmospheric fluxes. Trend changes in these kinds of atmospheric circulations have an impact on rainfall distributions and eventually on streamflow.